Preface

Electrical impedance tomography (EIT) seeks to recover the electrical conductivity distribution inside a body from measurements of current flows and voltages on its surface. The vast and growing literature reflects many possible applications of EIT techniques, *e.g.*, for medical diagnosis or nondestructive evaluation of materials.

Since the underlying inverse problem is nonlinear and severely ill-posed, general purpose EIT reconstruction techniques are likely to fail. Therefore it is generally advisable to incorporate a-priori knowledge about the unknown conductivity. One such type of knowledge could be that the body consists of a smooth background containing a number of unknown small inclusions with a significantly different conductivity. This situation arises for example in breast cancer imaging or mine detection. In this case EIT seeks to recover the unknown inclusions. Due to the smallness of the inclusions the associated voltage potentials measured on the surface of the body are very close to the potentials corresponding to the medium without inclusion. So unless one knows exactly what patterns to look for, noise will largely dominate the information contained in the measured data. Furthermore, in applications it is often not necessary to reconstruct the precise values of the conductivity or geometry of the inclusions. The information of real interest is their positions and size.

The main purpose of this book is to describe fresh and promising techniques for the reconstruction of small inclusions from boundary measurements in a readable and informative form. These techniques rely on accurate asymptotic expansions of the boundary perturbations due to the presence of the inclusions. The general approach we will take to derive these asymptotic expansions is based on layer potential techniques. This allows us to handle inclusions with rough boundaries. In the course of deriving our asymptotic expansions, we introduce new concepts of generalized polarization tensors (GPT's). GPT's contain significant information on the inclusion which will be investigated. We then apply the asymptotic expansions for designing efficient direct reconstruction algorithms to detect the location, size, and/or orientation of the unknown inclusions.

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